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ABSTRACT

In 1987-88, the Florida State Board of Community Colleges and the Division of Vocational, Adult, and Community Education jointly conducted a review of instructional programs in computer science and data processing in order to determine needs for state policy changes and funding priorities. The process involved a review of printed resources on computer training, model curricula, course standards, labor market statistics, and other program evaluations; an analysis of data extracted from the state's management information system; and a three-day statewide conference. Information was collected on programs, occupational supply and demand, enrollments, graduation rates, student follow-up, curricula, equipment, facilities, and faculty development activities. Selected findings included the following: (1) 55 computer science and data processing associate in science degree and certificate programs were identified in community colleges; (2) 53 business data processing programs were identified in area vocational-technical centers in 21 of the 67 public school districts in the state; (3) the Florida Occupational Information System projected 16% more data processing jobs and 22% more computer programming and system analysis jobs in 1992 than in 1988; and (4) in 1986-87, computer science and data processing enrollments totalled 6,405 in area vocational-technical centers and 5,949 in community colleges. Based on study findings, 16 recommendations were developed for improving programs, organizational structures, and interinstitutional coordination. (AJL)

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ED301297

A Comprehensive Review of Computer Science and Data Processing Education in Community Colleges and Area Vocational-Technical Centers

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By
State Board of Community Colleges
Division of Vocational, Adult and Community Education

May 18, 1988

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PREFACE

The review of instructional programs in community colleges and area vocational-technical centers is a multi-level process, involving institutional personnel, students, representative employers, regional and state Department of Education personnel, affected state agencies and organizations, and consultants. This review is a statewide, issue-oriented review, primarily to discover needs for state policy changes and funding priorities.

Computer science and computer data processing constitute a relatively new instructional field that has been and is characterized by unusually rapid growth and change due to the rapid growth and change in computer development and application in business and industry and for personal use. The resulting changes in employment needs, enrollment, curriculum, and equipment prompted this review.

Appreciation is expressed to the many people who participated in this review; including the personnel from the community colleges, universities, and area vocational-technical centers who took part in the Postsecondary Computer Education Programs in Transition Conference; the personnel from the regional offices of

the Division of Vocational, Adult and Community Education who determined equipment and facility needs; the personnel from the state office of the Division of Vocational, Adult and Community Education; and the staff of the Division of Universities who provided the results of their review of computer science in the State University System and helped with the planning of this review and the conference. Special appreciation is expressed to W. Carolyn Allen and B. Joan Tiller who handled the planning and conduct of the conference.

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INTRODUCTION

The State Board of Community Colleges is required to review instructional programs in community colleges (Section 240.311(3)(c), Florida Statutes) every five years (Section 240.312, Florida Statutes). The Division of Vocational, Adult and Community Education is required to review instructional programs in area vocational-technical centers (Section 229.551(3)(g), Florida Statutes). The Division cooperated with the Board in the conduct of this review, since the area vocational-technical centers and the community colleges offer the same, similar, and related instructional programs in computer science and data processing.

The computer has been brought more rapidly into the economy, affecting more industries and more people than nearly any other technological innovation, asserts the National Commission for Employment Policy in Research Report 85-09. In view of that impact, the Commission decided to find out what training is required for work with computers or computer-controlled equipment. What the Commission discovered provides a good setting for this report and is paraphrased below.

The main conclusion of the Commission is that computer use is widespread and growing rapidly, but few

workers need much preparation in computer-related skills. Most workers can learn necessary skills in brief, on-the-job training. Workers can be placed in three catagories.

1. Extensive education and training are necessary for about five percent of computer users. These are the designers of computers, teachers of computer science, programmers, analysts, and repairers.

2. Perhaps as little as a single college course is necessary for about another five percent of computer users. These are the professional and technical workers who cannot find appropriate software and have to write their own programs.

3. A few hours to a few weeks of training are necessary for the remaining ninety percent of computer users. These are the professionals, paraprofessionals, technicians, support people, and others who operate computers with available software.

The vast majority of computer training, therefore, is the training of workers to use computers as pieces of equipment in the performance of their jobs. Two points kept recurring during the Commission's investigation: computer skills in any occupation are a small part of the total work skills, opportunity for practice is essential in learning computer skills.

PURPOSE

The primary purpose of the statewide, issue-oriented review of computer science and data processing instructional programs in community colleges and area vocational-technical centers was to discover needs for state policy changes and funding priorities. The extreme growth and change in the field produces a very unstable field in which to plan and deliver instructional programs. In the summer of 1987, the Division of Universities completed a review of computer and information science instructional programs in the State University System, making a review of related programs in other postsecondary institutions a timely issue.

Other issues also prompted the review and guided its direction. Computer science and data processing instructional programs require extensive use of expensive equipment, which raises the question of whether the institutions are keeping up with the equipment changes in this rapidly changing field. Other issues intensified by the instability include whether vocational programs accurately reflect job opportunities in the field, whether program completion rates and job placement rates are reasonable, whether faculty keep up

with the field, whether the levels of job entry skills taught are appropriate, whether representative employers and instructional program managers interact effectively, and whether students who transfer into the State University System do well.

PROCESS

The process by which the computer science and data processing program review was conducted contained three basic elements: a search of print material, a search of the management information systems, a statewide conference. Each element is described below.

Print Material

Print materials, including papers, publications, and articles, were located and read. Those with particular significance to the program review were:

1. The research report of the National Commission for Employment Policy about how workers who use computers get their training, 1985.
2. The model curriculum for undergraduate computer information systems education prepared by the Data Processing Management Association Education Foundation Committee on Curriculum Development, 1985.
3. The vocational education program courses standards for business data processing prepared by the Division of Vocational, Adult and Community Education.

4. The computer science and data processing program level recommendations of the Vocational Program Level Core Committee of the Department of Education, 1988.
5. The report of the vocational instructional program review of business data processing programs conducted by the Division of Vocational, Adult and Community Eduction, 1987.
6. The Florida Occupational Information System labor market supply and demand estimates for data processing, computer programming, and systems analysis, 1987.
7. The report of the review of computer degree programs in the State University System conducted by the Division of Universities, 1987.
8. The Florida Statistical Abstract 1987.

Management Information System Data

Information from the management information systems was extracted and studied. Information with particular significance to the program review was:

1. The community college program review data displays for vocational and for associate in arts instructional programs.
2. The area vocational-technical center enrollment, completion, and placement data for

business data processing instructional programs.

3. The identification of computer science, computer engineering, and computer information systems courses in the Common Course Designation and Numbering System.

Statewide Conference

A three-day, statewide conference was conducted to deliberate the issues of the program review. There were ninety-seven participants representing twenty-one community colleges, fifteen area vocational-technical centers, six universities, the Division of Vocational, Adult and Community Education, and the State Board of Community Colleges. There were twenty-six representatives of computer equipment and software companies. Representative employers were on the program. The National Institute for Work and Learning and the National Commission for Employment Policy were represented on the program.

FINDINGS

Program Inventories

The program review identified fifty-five computer science and data processing associate in science degree programs and certificate programs in the State Community College System, in addition to lower division preparation for transfer to an upper division as a computer and information sciences major. Two of the twenty-eight community colleges did not offer computer science or data processing vocational programs. The vocational programs were offered under eighteen program titles. Refer to Table 1.

The review identified fifty-three business data processing programs in area vocational-technical centers in twenty-one of the sixty-seven public school districts. The vocational programs were offered under six program titles. Refer to Table 2.

The eighteen program titles in the community colleges in some instances constitute different names for the same program. The resulting confusion will be corrected if the recommendations from the Vocational Program Level Project are implemented. Community colleges and area vocational-technical centers would be required to use the same title and classification code

TABLE 1

Program Inventory
Computer Science/Data Processing
Community Colleges

Community Colleges	Business Applications	Business Data Processing		Computer and Info Systems	Computer Bus. Applications	Computer Info Specialist	Computer Operations	Computer Programming		Computer Science		Computer Science, Bus.		Computer Science, Eng.	Computer Systems	Computer Technology	Data Technician	Data Processing		Electronic Data Processing	Microcomputer Applications	Microcomputer Bus. Tech	Microcomputer Programming
	AS	AS	Ct	AS	Ct	AS	Ct	AS	Ct	AS	Ct	AS	Ct	AS	AS	AS	Ct	AS	Ct	AS	AS	Ct	Ct
Brevard								X															
Broward												X	X	X									
Central Florida																							
Chipola																		X					
Daytona Beach															X			X					
Edison										X	X												
Florida CCJ				X	X		X		X														
Florida Keys		X																		X			
Gulf Coast																		X	X				
Hillsborough	X					X										X			X		X		
Indian River										X	X												
Lake City								X											X				
Lake-Sumter										X	X							X	X				
Manatee								X															X
Miami-Dade		X																					
North Florida																							
Okaloosa-Walton																		X	X				
Palm Beach																X							
Pasco-Hernando																	X	X					
Pensacola									X	X													
Polk		X	X																				
Santa Fe								X	X														
Seminole																		X	X				
South Florida																		X	X				
St. Johns																		X					
St. Petersburg										X	X											X	
Tallahassee																			X				
Valencia									X									X					

for vocational programs that prepare for the same occupation.

Recommendation 1.-- Recommend the State Board of Community Colleges endorse the part of the Vocational Program Level Project that would require vocational instructional programs that prepare for the same occupation to use the same program title and classification code.

TABLE 2

Program Inventory
Business Data Processing
Area Vocational-Technical Centers

School Districts	Business Computer & Console Operation	Business Data Entry Equipment Operation	Business Data Processing	Computer Programmer	Computer Programming Trainee	Data Processing Operations
Broward	X	X		X		
Charlotte	X	X			X	
Collier			X			
Dade	X	X	X	X	X	X
Desoto			X			
Escambia			X			X
Hendry	X					
Hillsborough	X	X			X	
Lake						X
Lee				X		X
Leon		X	X		X	
Orange	X	X		X	X	X
Palm Beach					X	
Pinellas		X	X		X	X
Polk	X	X		X	X	
Santa Rosa						X
Sarasota			X			
St. Johns	X	X	X		X	X
Suwannee	X				X	X
Taylor					X	
Washington		X	X			

Manpower Supply and Demand

What the future holds for employment due to the "computer revolution" is not known. Some people predict that computers will replace many employees. Some people rush to instruction about computers, hoping to profit from the "computer age."

The National Commission for Employment Policy attempted to reduce the unknown by conducting a study of about 140 occupations in which workers use computers. The Commission found, and reported in Research Report 85-09, that computer use is growing rapidly, but only about five percent of the users need extensive training. The remaining users apply the computer as a tool that requires but a few hours of training followed by practice.

The confusion that results from such rapid application of a new instrument, which itself changes so rapidly, makes predictions of manpower supply and demand very difficult. The Florida Occupational Information System, a collaborative effort of several state agencies, attempts such predictions. The System has flaws, such as not factoring migration for a state growing as rapidly as Florida, but it is an improving, organized system. Applying the System to computer users

encounters even more difficulty, because the computer field has so little history, is so dynamic, and is growing so rapidly.

The Florida Occupational Information System projects sixteen percent more data processing jobs five years from now and twenty-two percent more computer programming and systems analysis jobs. The System finds an oversupply of people for data processing, 1,421 average annual openings for the next five years for the 2,270 average annual supply of workers. The System finds an undersupply of people for computer programming and systems analysis, 1,345 average annual openings for the next five years for the 427 average annual supply of workers. Refer to Table 3.

TABLE 3

Supply and Demand Estimates
Data Processing/Computer Programming/Systems Analysis
Florida Occupational Information System
1987

	Employment				
	1989	1994	Percent Change	Potential Supply	Average Annual Openings
Data Processing	28,119	32,498	16%	2,270	1,421
Computer Programming and Systems Analysis	24,988	30,556	22%	427	1,345

The National Commission for Employment Policy reports that computer programmers and systems analysts were in high demand from 1970 to 1985. In 1985, the computer industry experienced a widespread slowdown. Training programs that had been growing to meet the high demand began to catch up with the market. The Associated Press reports computer science enrollment in colleges is decreasing significantly, including institutions such as Northeastern University, Purdue University, University of California at Los Angeles, and University of North Carolina.

The Division of Universities reports that computer and information science enrollment in Florida universities is decreasing at the undergraduate level, thirty-four percent in the last two years, and increasing at the graduate level. Enrollment in computer science and data processing in Florida community colleges is decreasing: 10,542 in 1983-84, 9,281 in 1984-85, 7,167 in 1985-86, 5,949 in 1986-87. However, the enrollment in area vocational-technical centers increased from 5,919 in 1985-86 to 6,405 in 1986-87.

The computer industry slowdown in 1985 is one reason for enrollment decreases. Another is that the allure of computers as a fad is being replaced by understanding of the job market. Students have learned

that computer science is a rigorous discipline requiring extensive mathematics. The development of user-friendly equipment and packaged programs means that relatively few people need more than a few hours of training.

Participants at the statewide conference were optimistic despite the changing enrollment patterns. They estimated that for the near future, Florida's rapid growth will continue to result in jobs for computer science and data processing graduates, and will enable the community colleges and area vocational-technical centers to continue to meet a minimum standard of seventy percent placement for job preparatory programs.

Recommendation 2. -- Recommend the community colleges and area vocational-technical centers recognize the changing market for computer science and data processing jobs nationally and locally, and maintain close and regular interaction with current and potential employers of their graduates to keep a good balance of manpower supply and demand. Further, recommend that supply/demand information be given to students.

Enrollment, Completion, Follow-Up

Enrollment

Computer science and data processing enrollment in area vocational-technical centers was 6,405 in 1986-87, an increase of eight percent over the 1985-86 enrollment of 5,919. Computer science and data processing enrollment in community colleges was 5,949 in 1986-87, a decrease of seventeen percent from the 1985-86 enrollment of 7,167, and a decrease of forty-four percent in the three years from the 1983-84 enrollment of 10,542. During the same period, the number of computer science and data processing programs in community colleges increased from forty-one to fifty-five, a thirty-four percent increase. Despite the increase in the number of programs, Florida community colleges appear to be following the national trend for declining enrollment in computer science and data processing instructional programs. Refer to Table 4.

The 1986-87 enrollment in community colleges and the 496 completers (graduates) reported in Table 4 produce a completion rate of eight percent. The completion rate for the same period in the area vocational-technical centers is five percent. Allowing for the many problems with calculating placement rates,

TABLE 4

Program Data
Computer Science/Data Processing
Community Colleges/Area Vo-Tech Centers

	Community Colleges				Area Vo-Tech Centers		
	1983-84	1984-85	1985-86	1986-87	1984-85	1985-86	1986-87
Programs w/Enrollment	41	46	48	55	--	--	53
Enrollment	10,542	9,281	7,167	5,949	--	5,919	6,405
Programs w/Completers	38	37	39	40	22	35	36
Completers	599	668	532	496	385	359	332
Programs w/Placed Completers	34	36	37	--	22	35	--
Placed Completers	380	490	414	--	289	265	--
Overall Placement Rate	63%	73%	78%	--	75%	74%	--
Programs w/Less than 70% Placement	17	9	7	--	4	7	--
% Programs w/Less than 70% Placement	45%	24%	18%	--	18%	20%	--

the data still appear to support the several follow-up officers in the institutions who suggest that enrollment reporting does not distinguish adequately between students who enroll for a program and students who enroll for only one or two courses.

As in other fields, students who are curious about computer science and data processing may register for one or two of the courses to find out what the field and the curriculum are like. Some of them may decide to stay with the program, but the others have their curiosity satisfied and move into other programs. As in other fields, some employees in computer science and data processing identify one or two of the courses that they believe will help them at work. They register for those courses with no intention of completing all the courses in the program. Unlike in other fields, some students enroll in introductory computer science courses to achieve what has come to be called computer literacy. To provide reliable information about manpower supply, to determine a program completion rate, and to make sound curriculum decisions, such students with these valid objectives must be distinguished from other students who plan to complete the full program.

Recommendation 3. -- Recommend the community colleges and area vocational-technical centers assure that their procedures for recording enrollment consistently distinguish between and classify correctly the enrollment of students who enroll in complete job preparatory programs in computer science and data processing and the enrollment of students who enroll in

only one or several of the courses in the programs. The former are students preparing for the job. The latter are students seeking selected skills from the complete package rather than the complete package itself.

In 1986-87, fifty-nine percent of the community college students in computer science and data processing vocational programs were female. In 1985-86, the figure was sixty percent. In the area vocational-technical centers in 1986-87, the figure was sixty-eight percent. The Florida Statistical Abstract 1987 contains the 1986 estimate that fifty-two percent of the Florida population is female. Women do not appear to be under-represented in the programs. Refer to Table 5.

Black students in community college computer science and data processing vocational programs constituted thirteen percent of the enrollment in those programs in 1986-87 and twelve percent in 1985-86. Hispanic students constituted ten percent of the enrollment in those programs in 1986-87 and eight percent in 1985-86. The Florida Statistical Abstract 1987 contains the 1980 census finding that 13.8% of the Florida population is black and 8.8% is Hispanic. Representation in the programs for both groups is quite close to their proportion of the population.

Students identified as handicapped in community college computer science and data processing vocational programs constituted two percent of the enrollment in those programs in 1986-87 and in 1985-86. In the area

vocational-technical centers in 1986-87, the figure was five percent. The percentage of the Florida population that is handicapped was not determined during the review.

TABLE 5

Enrollment/Completion Distribution
Computer Science/Data Processing
Community Colleges/Area Vo-Tech Centers

	Community Colleges						Area Vo-Tech Centers	
	Enrollment				Completions		Enrollments	
	1985-86		1986-87		1986-87		1986-87	
	#	%	#	%	#	%	#	%
Male	2,895	40%	2,428	41%	234	47%	2,068	32%
Female	4,272	60%	3,521	59%	262	53%	4,337	68%
Alien	237	3%	176	3%	33	7%	--	--
Asian	152	2%	151	2%	16	3%	--	--
Indian	33	0	22	0	1	0	--	--
Black	869	12%	752	13%	35	7%	--	--
Hispanic	584	8%	591	10%	42	9%	--	--
White	5,292	74%	4,257	72%	369	74%	--	--
Handicapped	139	2%	144	2%	8	2%	321	5%

Completion

As shown in Table 4, the number of students who completed computer science and data processing vocational programs in area vocational-technical centers

was 332 in 1986-87, 359 in 1985-86, and 385 in 1984-85. The number in community colleges was 496 in 1986-87, 532 in 1985-86, 668 in 1984-85, and 599 in 1983-84. The numbers are decreasing, which might be expected in the community colleges, since the enrollment in these programs is decreasing.

The number of community college computer science and data processing programs with completers increased from thirty-eight to forty over the last four years, relatively little change. However, the number of programs with enrollment increased from forty-one to fifty-five over the last four years, an average increase of nearly five from one year to the next. Consequently, the number of programs with no completers any given year is increasing. In 1986-87, fifteen of the programs, twenty-seven percent, had no completers. This information adds to the support for recommendation three about correctly recording student enrollment intent, and recommendation eight about limiting job preparatory programs to job entry level knowledge and performance expectations of employers.

Follow-Up

Students who complete transfer programs and job preparatory programs at community colleges and area vocational-technical centers are kept track of to help determine the effectiveness of the programs. If they

find jobs that use the competence acquired in their job preparatory programs, or if they enter military service, or if they continue in postsecondary education, the completers (graduates) are considered to be placed.

Of the students who completed job preparatory programs in computer science and data processing in community colleges, the 1985-86 overall placement rate was seventy-eight percent, the 1984-85 rate was seventy-three percent, and the 1983-84 rate was sixty-three percent. The same three years, the percentages of individual programs with less than a seventy percent placement rate were eighteen percent, twenty-four percent, and forty-five percent. Expressed another way, the overall placement rate has improved to seventy-eight percent, and individual programs with placement rates below seventy percent have decreased to eighteen percent of the programs.

The cause of improved placement rates is not clear. Participants at the statewide conference offered several explanations. Improved tracking of students after graduation frequently is suggested as a cause. Another possibility is adjustment of program planning to the needs of the job market. What is clear is that the job market is fluid and interaction with employers is important.

Of the students who completed job preparatory programs in computer science and data processing in area

vocational-technical centers, the 1985-86 overall placement rate was seventy-four percent and the 1984-85 rate was seventy-five percent. The same two years, the percentages of individual programs with less than a seventy percent placement rate were twenty percent and eighteen percent.

Seven out of thirty-nine programs with completers in community colleges and seven out of thirty-five programs with completers in area vocational-technical centers had less than seventy percent of their completers placed, according to the most recent placement information. That same year, nine community college programs did not produce any completers. Also, the number of programs is increasing. This raises the need for the institutions to review their program structures and curricular objectives in light of job market needs. This information adds to the support for recommendations two and eight about interaction with employers.

Associate in arts level I program review tracks community college graduates who enter Florida universities, and compares their upper division performance with the upper division performance of other transfer students and of native students. Student record tapes are obtained from the State University System and student performance information is extracted

to produce the comparison. Table 6 shows the upper division performance of computer and information science students in the State University System in 1986-87. The information was provided by the Division of Universities.

TABLE 6

Student Performance in SUS
Computer and Information Science
1986-87

	Florida CC AA Graduates	Florida CC AS Graduates	Other Transfers	SUS Natives
Unduplicated Upper Division Headcount	2,106	87	1,502	1,144
Mean Cumulative GPA	2.65	2.97	2.79	2.84
Percent at 3.0 or Above	31.3%	56.3%	41.8%	39.1%
Percent Below 2.0	12.5%	5.7%	8.7%	1.9%
Percent Suspended	3.9%	1.1%	2.4%	.7%
Percent Graduated	15.1%	9.2%	14.3%	22.0%
Average Credits Attempted per Term	6.6	7.3	6.9	9.2
Average Credits of Graduates	140.9	157.4	142.7	135.3

It is interesting to note that there were eighty-seven Florida community college associate in science degree graduates in computer and information science programs in the SUS in 1986-87. Their mean

cumulative grade point average was higher than that of the associate in arts graduates, or other transfers, or even the natives. A larger percentage of them had grade point averages of 3.0 or above. Only the natives had a smaller percentage below 2.0. Only the natives had a smaller percentage suspended. However, a smaller percentage graduated during the year, and more courses were required toward graduation. An obvious question is to wonder why the associate in science graduates performed so well.

Recommendation 4.-- Recommend the 1987-88 performance of Florida community college associate in science degree graduates who enter computer and information science upper division programs in the State University System be determined. Further recommend that if the high performance of 1986-87 is repeated, a study be conducted to determine the causal factors.

Associate in arts degree graduates did not perform as well in 1986-87 as their fellow associate in science degree graduates in the computer and information science upper division programs. Table 6 shows their mean cumulative grade point average was one-tenth of a point lower than that of other transfers, two-tenths of a point lower than that of natives, and three-tenths of a point lower than that of associate in science graduates. A smaller percentage of them had grade point averages at 3.0 or above. A larger percentage of them had grade point averages below 2.0. A larger percentage of them were suspended. But, only the natives had a higher percentage graduate. Only the natives required

fewer courses to graduate, and the difference was an average of only 5.6 credits. This information adds to the support for recommendation six about community college faculty meeting with colleagues from the universities to obtain the interaction necessary for program development. Such meetings are the heart of the level II associate in arts program review process. The issue is better preparation of students to compete in the upper division.

The process of keeping track of students who complete or leave transfer programs and job preparatory programs in community colleges and area vocational-technical centers to determine what they do with what they learned in their programs and how well the programs contributed to what they do involves extensive information collection, analysis, and utilization with many people participating. It is an extensive series of tasks calling for difficult skills, and requires much direction and coordination. The benefits of an effective follow-up process on instructional development are significant. But, such a process is very expensive, requiring many man-hours and machine-hours. The institutions have not been able to direct enough resources to the follow-up process, and the potential of the process is not being realized.

Recommendation 5.-- Recommend a budget issue be developed for the next legislative budget request to provide sufficient funds for each institution to raise its follow-up process to the optimum.

Curriculum

This discussion of selected curriculum concerns regarding computer science and data processing instruction draws heavily upon points raised during the statewide conference. The types of endeavor in computer science and data processing instruction are to prepare students for upper division programs in computer and information science, to prepare students for jobs in computer science and data processing, to prepare employees in computer science and data processing to perform better and to perform additional skills, and to prepare students who are not seeking computer science and data processing jobs with computer awareness and skills to apply in their activities. Each type of endeavor logically requires the anticipation of what is necessary at the next step, whether that next step is the upper division, the job, or other activity.

When the next step is the upper division, the curriculum, quite obviously, should be conceived, designed, and delivered to prepare students to make smooth and successful transitions to the upper division with all the knowledge and skill judged necessary to compete successfully in the upper division. Prerequisite to such a curriculum is knowledge of the

upper division curriculum and expectations, which is obtained by interaction with the upper division. Is such interaction a structured and regular occurrence?

Four community colleges reported level II program review meetings with computer and information science faculty at five universities last year. The observations of participants in the statewide conference suggest that such meetings are not widespread, structured, or regular.

The report of the review of computer degree programs in the State University System conducted by the Division of Universities contains the finding that some university faculty are uneasy with the preparedness of undergraduates. Increased interaction with community colleges is suggested in that report.

Recommendation 6.-- Recommend each community college that prepares students for computer and information science upper division programs schedule annual planned meetings between the community college program faculty and colleagues from each university where many of the college's computer science and data processing students transfer, in order to obtain the interaction necessary for effective program development at the college.

When the next step is the job, the curriculum, quite obviously, should be conceived, designed, and delivered to prepare students for job entry. Prerequisite to such a curriculum is knowledge of the job market and employer expectations, which is obtained by interaction with employers. Is such interaction a

structured and regular occurrence?

The mechanism exists for such interaction, the local craft or program advisory committees. The community colleges and the area vocational-technical centers all have such committees composed of employers, managers, and former students. The report of the vocational instructional program review of business data processing programs conducted by the Division of Vocational, Adult and Community Education states, "Programs reviewed statewide indicated no significant problem with support from active advisory committees." The report does not contain a finding of the effectiveness or impact of the advisory committees on curriculum. The report does say that several advisory committee members who participated in the review recommended more attention to the basics, such as oral communication and keyboarding.

Participants at the statewide conference consistently expressed the importance of local needs assessment to determine the curriculum. Local needs assessment mainly is interaction with employers. Employers who attended the statewide conference as panelists and speakers expressed the same belief, saying that the institutions need to learn what business expects and to act accordingly. The repeated admonitions about interaction with employers and the

employer comments about curriculum reported below raise questions about the impact of advisory committees on curriculum.

Recommendation 7.-- Recommend the business/industry technical review process of the Division of Vocational, Adult and Community Education include evaluation of the impact of advisory committees on curriculum decisions.

Employers at the statewide conference said the curriculum should produce students who can and will do what the employer needs employees to do. They want new hires to be able to apply their skills immediately upon being hired, including whatever business and communication skills are associated with the job in addition to the computer use skills. They want employees who can read and who are prepared to accept and adapt to change. They believe curriculum should be evaluated at least annually. They said students should be trained to job entry level, with continuing education following later. They believe job needs should determine the curriculum.

Recommendation 8.-- Recommend the community colleges and area vocational-technical centers assure that the curricula of their computer science and data processing job preparatory programs are built to the specifications of the job entry level knowledge and performance expectations of the employers.

When the next step is activity associated with an employee's job, the curriculum, quite obviously, should be conceived, designed, and delivered to prepare the student to perform better or to perform additional

skills on the job. Prerequisite to such a curriculum is knowledge of the performance deficiency and expectation or knowledge of the additional skill to be performed, both of which are obtained by interaction with the employer and employee. When the next step is personal activity, the curriculum, quite obviously, should be conceived, designed, and delivered to prepare the student to perform the skills necessary for that activity. Prerequisite to such a curriculum is knowledge of the activity, which is obtained by interaction with the individual. These last two types of endeavor depend on the same principle for curriculum development as the first two and further support recommendation seven.

Vocational instructional programs in computer science and data processing that are offered in area vocational-technical centers frequently contain knowledge and skill expectations similar to those contained in the college credit programs offered in community colleges. Students frequently move between the two systems, which raises the issues of expectations, duplication, and recognition of prior learning. Again, interaction is necessary. Participants at the statewide conference and employers who attended as panelists and speakers agreed, and recorded it as a recommendation.

Recommendation 9.-- Recommend each community college with computer science and data processing programs and each area vocational-technical center with related programs in the college district schedule annual planned meetings between the program faculties of the institutions to obtain the interaction necessary for effective program development.

There were other curriculum observations at the statewide conference with which some agreement was expressed. Cooperative education was identified as an effective instructional methodology. The various forms of follow-up evaluation should impact curriculum. Continuing education is a fertile field for computer science and data processing instruction, because of the limited needs of many computer users and because of the rapid change in the field. The rapid change makes it difficult for curriculum to keep pace. Responsiveness to the local market needs and adherence to vocational education program courses standards for business data processing prepared by the Division of Vocational, Adult and Community Education frequently are difficult to combine.

Recommendation 10.-- Recommend the Division of Vocational, Adult and Community Education, the Division of Community Colleges, and the Division of Universities annually organize a statewide conference similar to the statewide conference conducted as part of the computer science and data processing program review.

The report of the review of computer degree programs in the State University System conducted by the Division of Universities contains two adopted

recommendations that affect community college curriculum. One is that universities phase out their computer technology programs so that they can concentrate their resources on their computer degree programs. The other is that community colleges be encouraged to offer introductory major courses in computer science to transfer into the universities' programs, because introductory major courses are placed naturally in the lower division and the community college transfer should have the opportunity to be on equal footing with the native university junior.

Questions and discussion at the statewide conference suggest that not everyone understands the Common Course Designation and Numbering System. Area vocational-technical center courses being in the System, and the protection of course credit when students transfer are elements of the System which some of the conference participants did not understand. The participants expressed knowledge of cases where transfer students were required to repeat courses at receiving community colleges and universities.

Recommendation 11.-- Recommend the position of the Board of Regents to encourage community colleges to offer introductory major courses in computer science be used by the community colleges during their annual planned meetings with university computer and information science faculty to develop some community college computer courses mutually.

Recommendation 12.-- Recommend the Articulation Coordinating Committee establish a subject area

articulation group for computer science and data processing to study interaction issues between and among universities, community colleges, and area vocational-technical centers regarding computer science and data processing curriculum.

Equipment

Computer science and data processing instructional programs require the use of expensive equipment and software. Program specialists from the Division of Vocational, Adult and Community Education and local program advisory committee members visited the community college and area vocational-technical center programs to determine whether instructional resources are available to meet student performance standards. They found that a significant number of the programs don't have enough up-to-date equipment and software to meet program objectives, and that many programs lack equipment replacement schedules. The deficiencies are listed in detail in the appendix and are summarized in Table 7.

TABLE 7

Equipment and Software Needs
Computer Science/Data Processing

	Community Colleges	Area Vo-Tech Centers
General Equipment	$ 396,763	$ 495,654
Specialized Equipment	4,571,150	1,956,540
Specialized Resources Software	978,000	1,335,000
Total	$5,945,913	$3,787,194

Recommendation 13.-- Recommend the State Board of Community Colleges and the Department of Education include in their legislative budget requests $5,945,913 for community colleges and $3,787,194 for area vocational-technical centers to obtain up-to-date equipment and software to enable computer science and data processing instructional program standards and objectives to be met.

Recommendation 14.-- Recommend the community colleges and area vocational-technical centers adopt equipment replacement schedules for the equipment in computer science and data processing instructional programs.

Facilities

Program specialists from the Division of Vocational, Adult and Community Education and local program advisory committee members visited the community colleges and area vocational-technical center programs to determine whether the facilities in which the programs are housed enable student performance standards to be met. They found that ten percent of the community college programs are housed in facilities deficient in laboratory dimensions, storage space, sound proofing, instructional planning area, electrical services, and safety measures. They found that twenty-four percent of the area vocational-technical programs are housed in facilities deficient in laboratory dimensions, storage space, sound proofing, and instructional planning area; and that fifty percent are deficient in electrical services and safety measures.

Recommendation 15.-- Recommend the community colleges and area vocational-technical centers that house computer science and data processing instructional programs in facilities determined to be deficient by the vocational instructional program review of business data processing programs conducted by the Division of Vocational, Adult and Community Education incorporate that determination in their planning for facilities construction, remodeling, and renovation.

Faculty Development

Faculty development was among the more frequently mentioned concerns at the statewide conference. The computer science and data processing field is developing so rapidly, with the technology changing constantly, that instructors find the responsibility of keeping current in their field to be particularly difficult.

Faculty are expected to know and understand the technology and its application in business, engineering, scientific, personal, and other computer use. They must understand the job market and know what employers expect. They must interact with their counterparts in high schools and universities. And, all this occurs in the midst of such rapid change in the technology and its application that faculty must anticipate needs for change in their curriculum development and must prepare their students for change.

Traditional means of faculty development include participation in professional organizations; studying publications; attending classes, conferences, and workshops; and visiting other programs. Participants and employer speakers and panelists at the statewide conference emphasized two other means of faculty development. One is the exchange of personnel between

education and business. The other is cooperative education.

Cooperative education usually is viewed as a method of instruction. When faculty are trying to keep in touch with the field they teach, supervising several students on cooperative education assignments is another way of keeping in touch.

Instructional programs frequently use employers and employees as part-time instructors. But, faculty do not frequently receive leave from their community colleges and area vocational-technical centers to work in the field they teach, and that is what those at the statewide conference urged. They believe six months should be the minimum length of such leave, and that the colleges and centers should provide the incentives to enable such experiences. The Vocational Inservice and Business Exchange Program funded through the Division of Vocational, Adult and Community Education can help with some of the arrangements and funding, but the responsibility is with the institutions to arrange for such faculty development to the extent of the need. In 1987-88, twenty-one computer science and data processing faculty received help through the program, but for periods shorter than six months.

Recommendation 16.-- Recommend the community colleges and area vocational-technical centers accept responsibility for arranging for their computer science and data processing vocational instructional program faculty periodically to work full time for at least six-month periods in computer science and data processing jobs.

SUMMARY

Computer use is widespread and growing rapidly, but few workers need much preparation in computer-related skills. Most workers can learn necessary skills in brief, on-the-job training. The vast majority of computer training is the training of workers to use computers as pieces of equipment in the performance of their jobs. Computer skills are a small part of the total work skills, and the opportunity for practice is essential in learning computer skills.

The review dealt with program inventories, manpower supply and demand, enrollment, completion, follow-up evaluation, curriculum, equipment, facilities, and faculty development. The findings resulted in recommendations of four types. Five recommendations concern operational structure and planning (#1, #3, #10, #14, #15). Four recommendations concern interacting with employers (#2, #7, #8, #16). Five recommendations concern articulation between and among universities, community colleges, and area vocational-technical centers (#4, #6, #9, #11, #12). Two recommendations are legislative budget issues (#5, #13).

Several items should be emphasized. The dynamic nature of the computer science and data processing field

absolutely demands close and constant interaction between job preparatory programs and employers. The dynamic nature of the field further requires regular and structured interaction among the various levels of instructional delivery institutions. Finally, the complex technological change is so rapid that keeping the very expensive instructional equipment up to date is a particular problem.

The recommendations in this report are prompted by the findings of the program review and reflect the dynamic nature of the computer science and data processing field.

RECOMMENDATIONS

These recommendations first appear in the chapter on findings, along with the information that supports them. They are repeated here for easy reference.

1.-- Recommend the State Board of Community Colleges endorse the part of the Vocational Program Level Project that would require vocational instructional programs that prepare for the same occupation to use the same program title and classification code.

2.-- Recommend the community colleges and the area vocational-technical centers recognize the changing market for computer science and data processing jobs nationally and locally, and maintain close and regular interaction with current and potential employers of their graduates to keep a good balance of manpower supply and demand. Further, recommend that supply/demand information be given to students.

3.-- Recommend the community colleges and area vocational-technical centers assure that their procedures for recording enrollment consistently distinguish between and classify correctly the enrollment of students who enroll in complete job preparatory programs in computer science and data

processing and the enrollment of students who enroll in only one or several of the courses in the programs. The former are students preparing for the job. The latter are students seeking selected skills from the complete package rather than the complete package itself.

4.-- Recommend the 1987-88 performance of Florida community college associate in science degree graduates who enter computer and information science upper division programs in the State University System be determined. Further recommend that if the high performance of 1986-87 is repeated, a study be conducted to determine the causal factors.

5.-- Recommend a budget issue be developed for the next legislative budget request to provide sufficient funds for each institution to raise its follow-up process to the optimum.

6.-- Recommend each community college that prepares students for computer and information science upper division programs schedule annual planned meetings between the community college program faculty and colleagues from each university where many of the college's computer science and data processing students transfer, in order to obtain the interaction necessary for effective program development at the college.

7.-- Recommend the business/industry technical review process of the Division of Vocational, Adult and Community Education include evaluation of the impact of

advisory committees on curriculum decisions.

8.-- Recommend the community colleges and area vocational-technical centers assure that curricula of their computer science and data processing job preparatory programs are built to the specifications of the job entry level knowledge and performance expectations of the employers.

9.-- Recommend each community college with computer science and data processing programs and each area vocational-technical center with related programs in the college district schedule annual planned meetings between the program faculties of the institutions to obtain the interaction necessary for effective program development.

10.-- Recommend the Division of Vocational, Adult and Community Education, the Division of Community Colleges, and the Division of Universities annually organize a statewide conference similar to the statewide conference conducted as part of the computer science and data processing program review.

11.-- Recommend the position of the Board of Regents to encourage community colleges to offer introductory major courses in computer science be used by the community colleges during their annual planned meetings with university computer and information science faculty to develop some community college computer courses mutually.

12.-- Recommend the Articulation Coordinating Committee establish a subject area articulation group for computer science and data processing to study interaction issues between and among universities, community colleges, and area vocational-technical centers regarding computer science and data processing curriculum.

13.-- Recommend the State Board of Community Colleges and the Department of Education include in their legislative budget requests $5,945,913 for community colleges and $3,787,194 for area vocational-technical centers to obtain up-to-date equipment and software to enable computer science and data processing instructional program standards and objectives to be met.

14.-- Recommend the community colleges and area vocational-technical centers adopt equipment replacement schedules for the equipment in computer science and data processing instructional programs.

15.-- Recommend the community colleges and area vocational-technical centers that house computer science and data processing instructional programs in facilities determined to be deficient by the vocational instructional program review of business data processing programs conducted by the Division of Vocational, Adult and Community Education incorporate that determination

in their planning for facilities construction, remodeling, and renovation.

16.-- Recommend the community colleges and area vocational-technical centers accept responsibility for arranging for their computer science and data processing vocational instructional program faculty periodically to work full time for at least six-month periods in computer science and data processing jobs.

APPENDIX

Needed Instructional Resources
Computer Science/Data Processing

Community Colleges

General Equipment

Quantity	Item	Unit Cost	Total Cost
837	Computer workstations w/posture chairs	$ 400	$334,800
221	Printer stands	87	19,227
136	Posture chairs	100	13,600
161	Diskette files	26	4,186
16	Melamine boards	200	3,200
305	Cables	30	9,150
126	Computer desks	100	12,600
			$396,763

Specialized Equipment

Quantity	Item	Unit Cost	Total Cost
1047	Microcomputers	$ 1,500	$1,570,500
13	Mini-computer system w/ peripheral equipment	60,000	780,000
397	Computer terminals	800	794,000
66	Laser printers	2,000	132,000
400	Printers	750	300,000

Quantity	Item	Unit Cost	Total Cost
58	Network expansion	3,500	203,000
172	Computer memory expansion	500	86,000
90	Disk drive (hard)	400	36,000
8	Mainframe networking system	15,000	120,000
77	Computer monitors	500	38,500
148	Network adapter cards	500	74,000
35	Modems	300	10,500
21	Computer projection image system	1,500	31,500
10	Hard disk micro networking system	12,000	120,000
91	Mouse system	200	18,200
7	Plotters	500	3,500
9	Telecommunications system	3,000	27,000
2	Printer-1200 line (on line printer)	10,000	20,000
6	Optical character reader	600	1,200
2	Communication boards for networking	150	300
52	w/cables	450	23,400
4	Local area networks (LAN)	10,000	40,000
5	Voice synthesizers	1,500	7,500
5	File servers	14,000	7,000
7	Compact disk/interactive	1,000	7,000
30	Graphic adapter cards	175	5,250
34	Printer switches	200	6,800
45	Printer buffer	1,000	45,000
			$4,571,150

Specialized Resources Software

Quantity	Item	Unit Cost	Total Cost
1494	Pre-programmed applications	500	747,000
77	Language compilers	3,000	231,000
			$ 978,000

Area Vocational-Technical Centers

General Equipment

Quantity	Item	Unit Cost	Total Cost
984	Computer workstations w/posture chairs	$ 400	$ 393,600
508	Printer stands	100	50,800
24	Melamine boards	200	4,800
54	Diskette files	26	1,404
102	Printer switches	100	10,200
15	Computer switching cables	30	450
330	Posture chairs	100	33,000
4	Storage racks	350	1,400
			$ 495,654

Specialized Equipment

Quantity	Item	Unit Cost	Total Cost
929	Microcomputers	$ 1,500	$1,395,500
7	Color graph PC	2,000	14,000
1	Printer-1200-line (on line)	10,000	10,000
20	Computer upgrades	480	9,600
3	Computer w/networking capability	1,200	3,600
20	Computer terminals	1,000	20,000
532	Printers	750	339,000
2	Optical character reader	600	1,200
2	Telecommunications unit	3,000	6,000

Quantity	Item	Unit Cost	Total Cost
10	Computer projection image system	3,000	30,000
1	Laser printer	2,000	2,000
154	Hard disk drives	500	77,000
8	Modems	80	640
4	Trackstar boards	300	1,200
14	Acoustic covers	200	2,800
2	Color graphic printer	1,500	3,000
			$1,956,540

Specialized Resources Software

Quantity	Item	Unit Cost	Total Cost
2670	Pre-packaged applications (i.e., Lotus 1.2.3., D.Base, Data Entry)	500	$1,335,000

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